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Lifetime Evaluation of a Battery Storage System used for Residential Electricity Supply in East Africa

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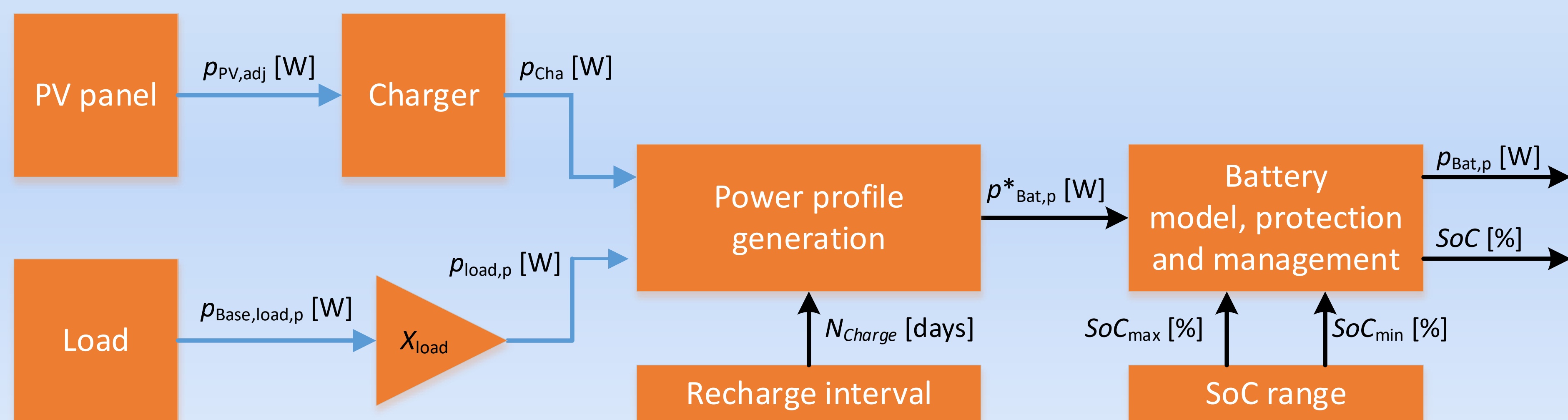
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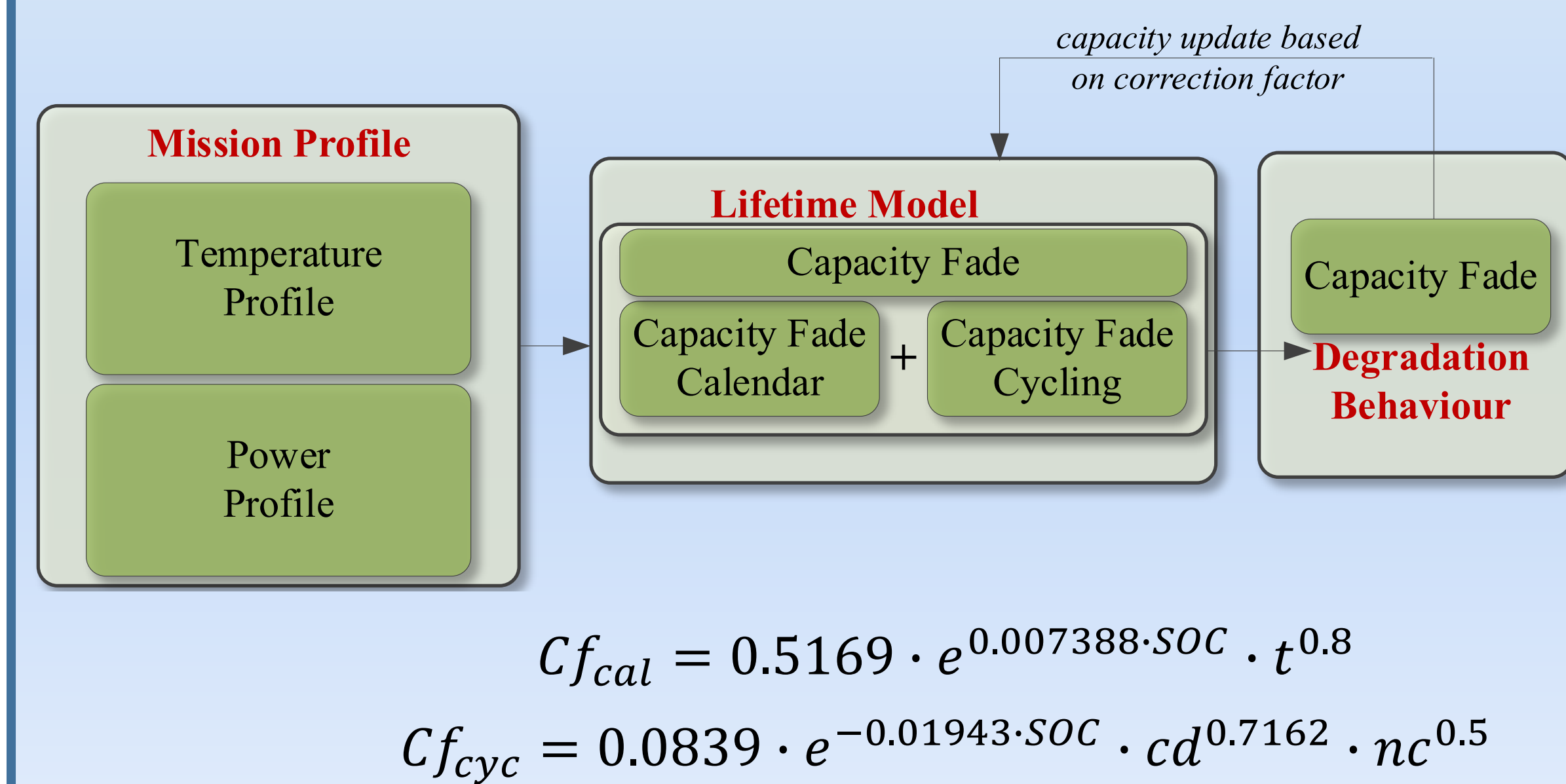
Introduction

- ❑ The lifetime is a key indicator for the battery performance in every application
- ❑ The battery lifetime is greatly influenced by the operating conditions to which the battery is subjected
- ❑ In this work, we have evaluated the lifetime of a Lithium-ion (Li-ion) battery, which is used for providing electricity for a residential home located in East Africa. The battery is recharged at least once per week from a photovoltaic panel.
- ❑ Different operating scenarios were used to evaluate the battery lifetime, by varying the battery recharging interval, the load profile, and the minimum and maximum allowed battery SOC → 23 study cases
- ❑ The battery capacity was selected as the indicator for the battery lifetime; a 20% decrease in battery capacity = end-of-life reached
- ❑ Li-ion batteries based on LCO chemistry are used

Battery Mission Profile Generation

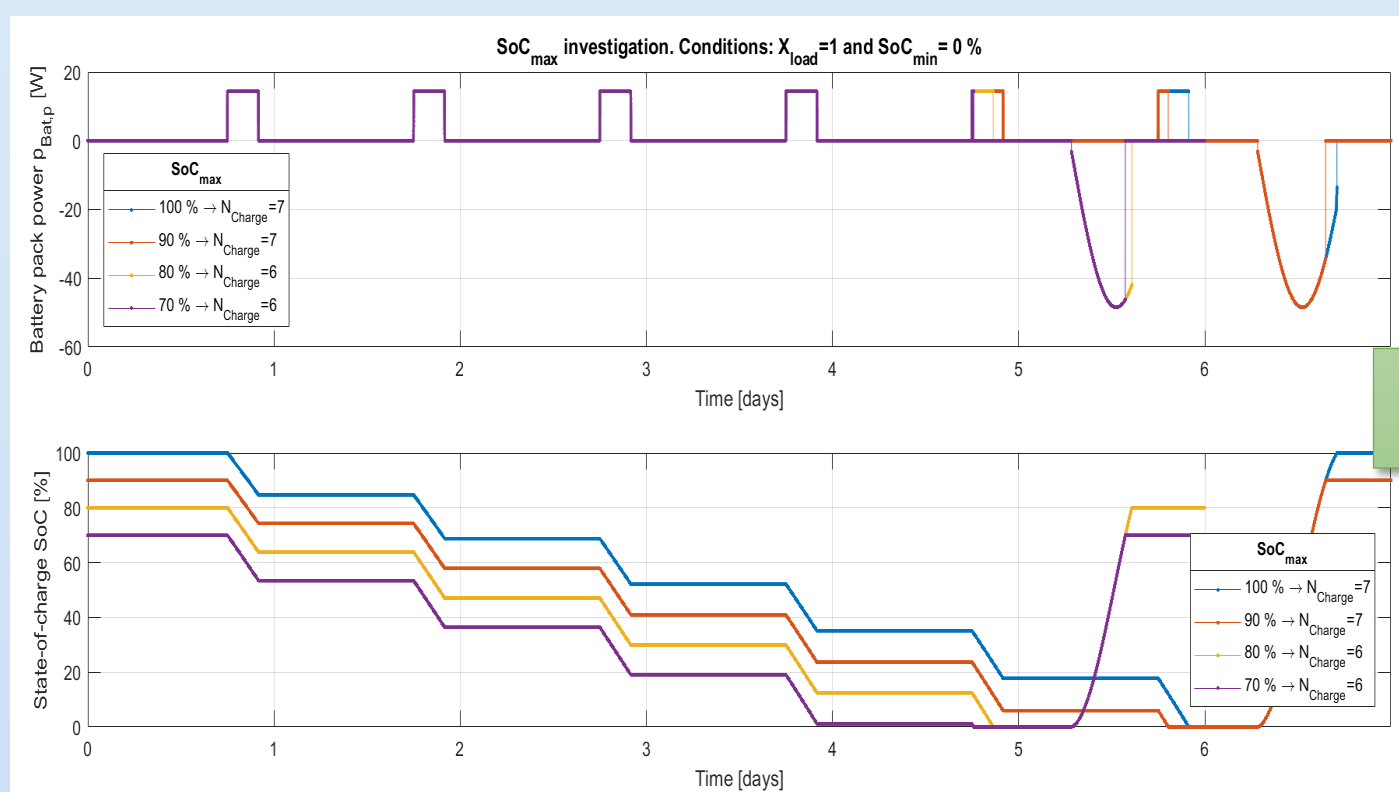


Battery Lifetime Calculation

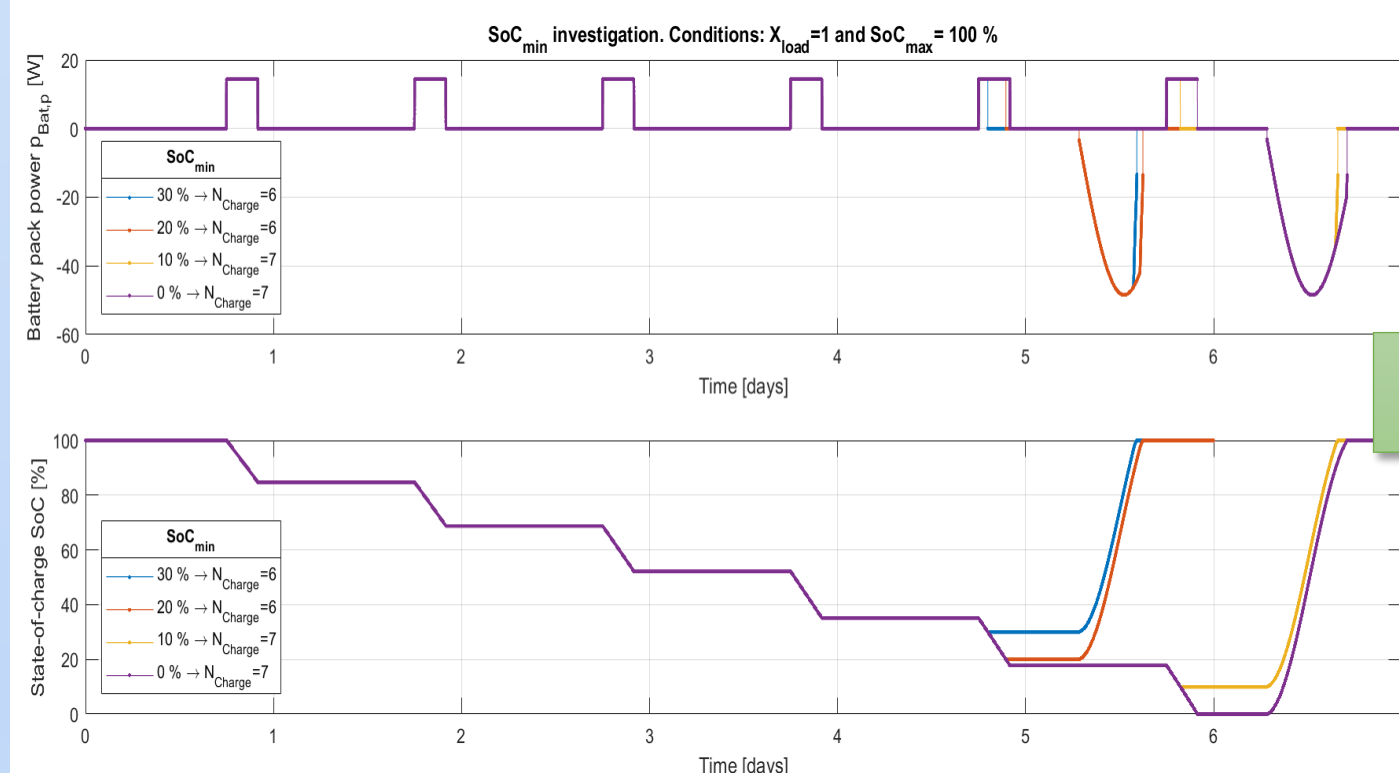


Study Cases

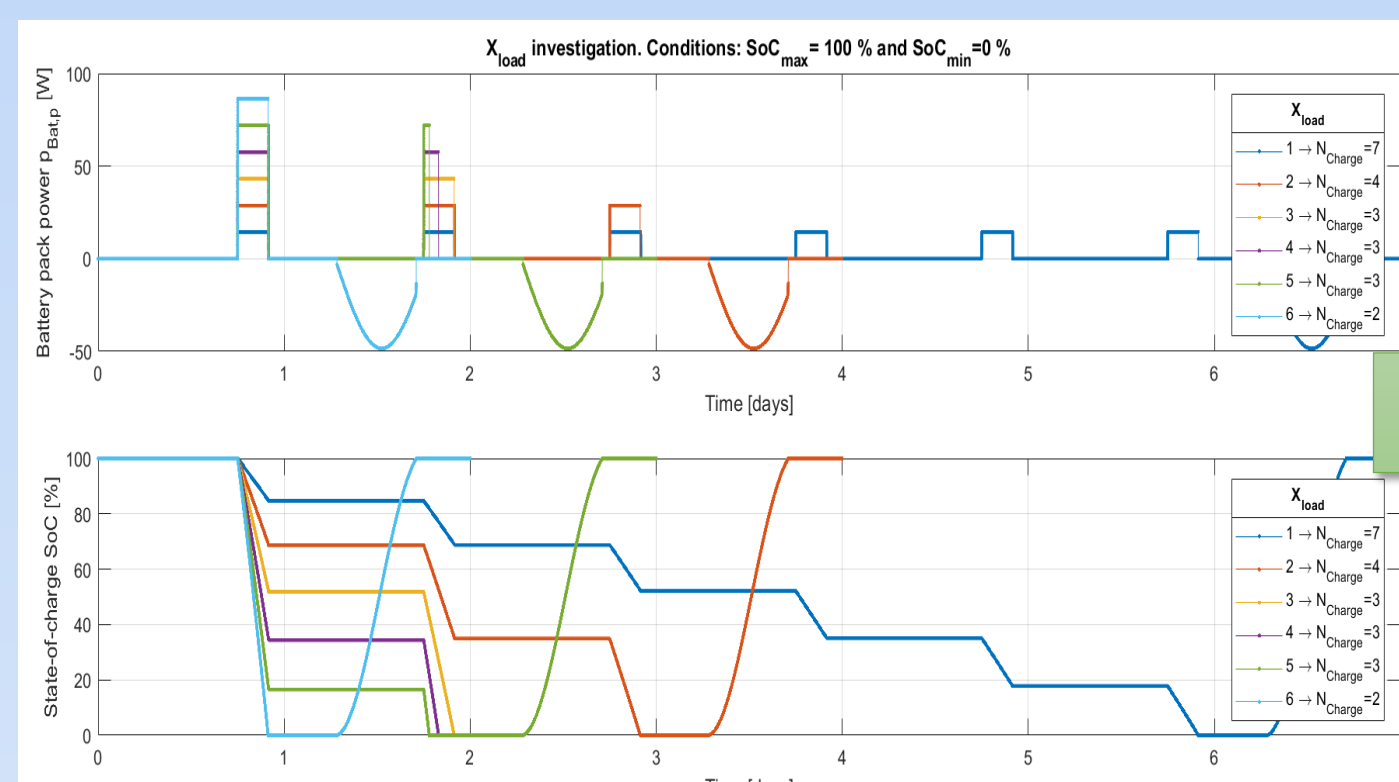
Max. SOC



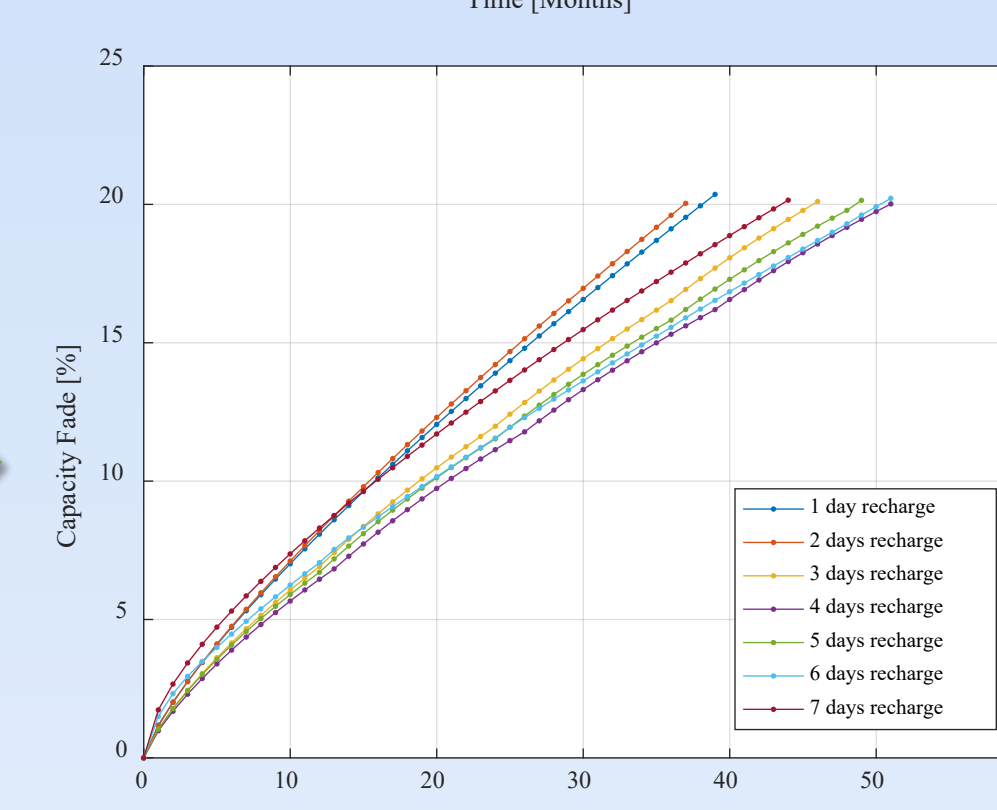
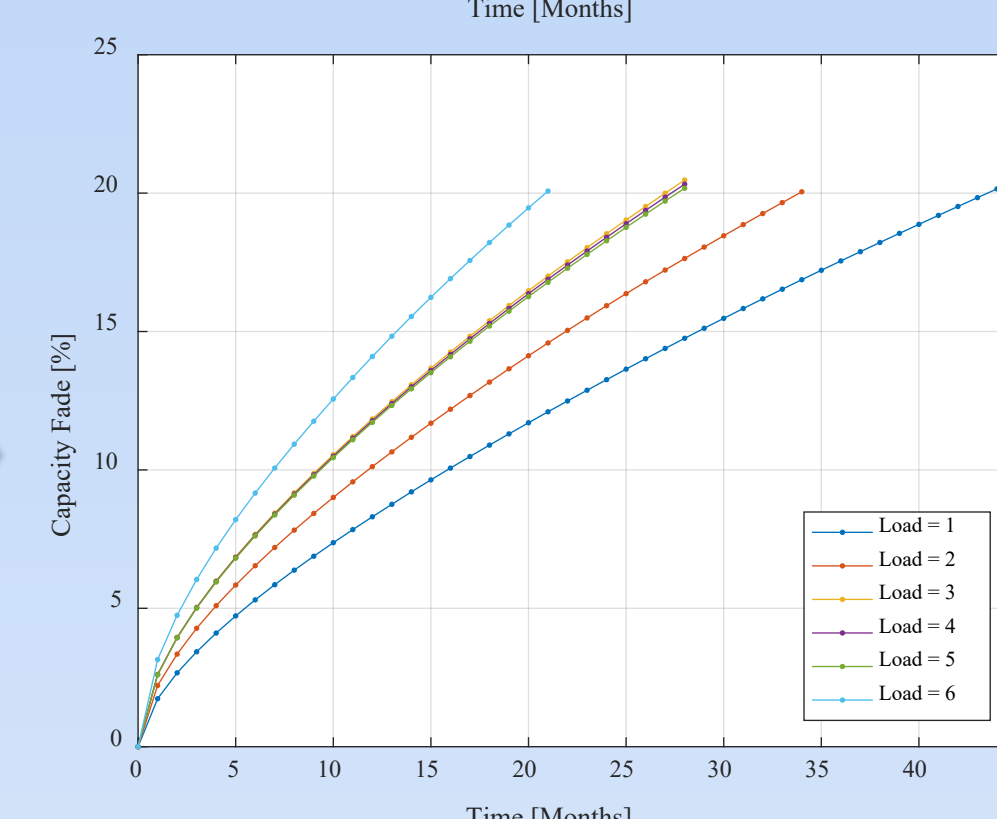
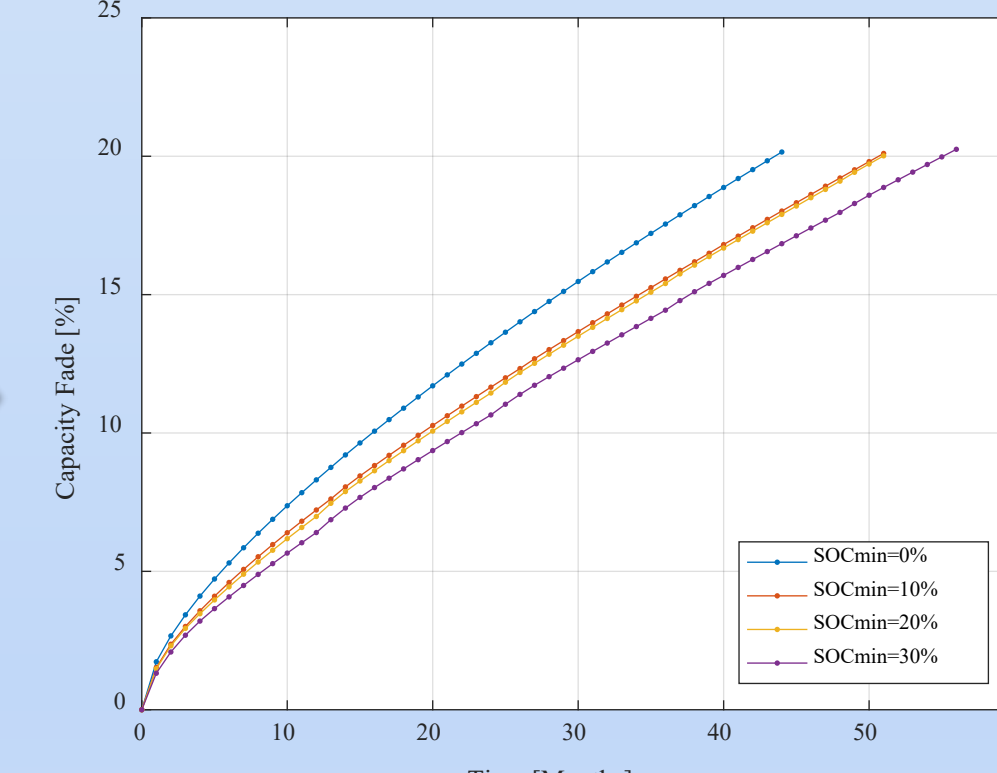
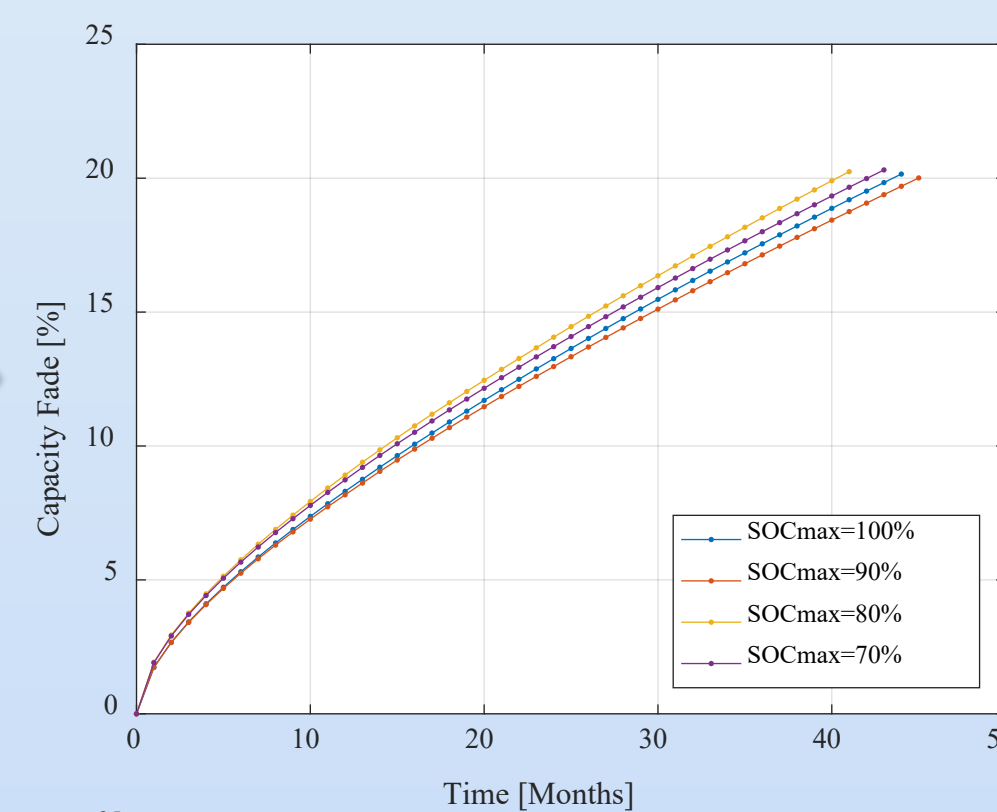
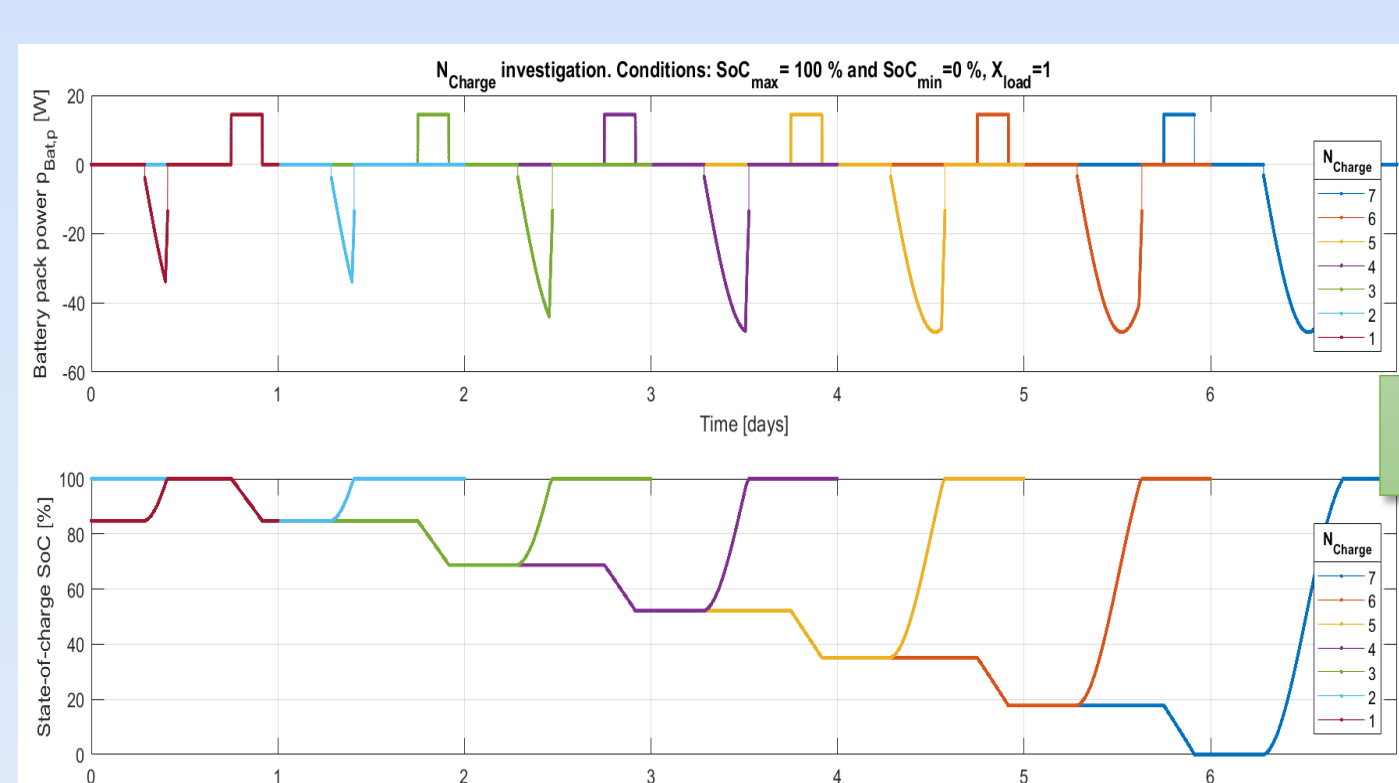
Min. SOC



Load Power



Recharge Time



Lifetime Evaluation

| SOC interval | Lifetime | Cap. fade - idling | Cap. fade - cycling |
|--------------|-----------|--------------------|---------------------|
| 100% - 0% | 44 months | 12.90 % | 7.24 % |
| 90% - 0% | 45 months | 12.34 % | 7.66 % |
| 80% - 0% | 41 months | 11.63 % | 8.61 % |
| 70% - 0% | 43 months | 11.38 % | 8.92 % |

| SOC interval | Lifetime | Cap. fade - idling | Cap. fade - cycling |
|--------------|-----------|--------------------|---------------------|
| 100 % - 30% | 56 months | 17.65 % | 2.59 % |
| 100 % - 20% | 51 months | 14.88 % | 5.50 % |
| 100 % - 10% | 51 months | 14.60 % | 5.50 % |
| 100 % - 0% | 44 months | 12.90 % | 7.24 % |

| X_load | Lifetime | Cap. fade - idling | Cap. fade - cycling |
|--------|-----------|--------------------|---------------------|
| 1 | 44 months | 12.90 % | 7.24 % |
| 2 | 34 months | 10.63 % | 9.41 % |
| 3 | 28 months | 9.83 % | 10.63 % |
| 4 | 28 months | 9.65 % | 10.66 % |
| 5 | 28 months | 9.46 % | 10.71 % |
| 6 | 21 months | 8.27 % | 11.80 % |

| Recharge | Lifetime | Cap. fade - idling | Cap. fade - cycling |
|----------|-----------|--------------------|---------------------|
| 1 day | 39 months | 19.60 % | 0.75 % |
| 2 days | 37 months | 19.67 % | 0.36 % |
| 3 days | 46 months | 17.25 % | 3.06 % |
| 4 days | 51 months | 15.85 % | 4.32 % |
| 5 days | 49 months | 14.78 % | 5.25 % |
| 6 days | 51 months | 15.98 % | 4.23 % |

- ❑ For the considered scenarios, lifetime expectances between 21 and 56 months were obtained.
- ❑ The maximum and minimum allowed battery SOC interval and the battery recharging interval have a non-linear effect on the lifetime of the considered battery